

# HEAT VS TEMPERATURE

- **Heat** =

- The total **energy** of molecular motion in a substance
- Depends on the speed, number, and type of particles in an object
- Measured in joules

- **Temperature** =

- A **measure** of the average energy of molecular motion in a substance
- Does NOT depend on size or type of object
- Measured in degrees

- Compare
  - A pot of boiling water vs a drop of boiling water
    - They have the same temperature
    - The pot of boiling water has more heat than the drop
- Thermometers measure temperature (NOT heat!!!)

- Phase changes require
  - The gain or loss of heat energy
  - You can't add or take away cold!
- Adding heat will increase the temperature of a substance
  - Higher temperatures mean that the molecules are moving, vibrating and rotating with MORE energy
- Removing heat will decrease the temperature of a substance
  - Lower temperatures mean that the molecules are moving, vibrating and rotating with LESS energy

- **Specific heat capacity** =
  - Heat required to raise unit mass of substance by one degree of temperature
  - Water-high
  - Metals-low
  - Handles-high
- Heat is energy
- Temperature is NOT energy, but a measure of it

# MEASURING TEMPERATURE

- Galileo made a **thermoscope** in 1596
  - Used to compare temperatures but no standardized scale
- Olaf Roemer made the first thermometer in 1701
- G. Daniel *Fahrenheit* altered Roemer's scale
  - 32° F – ice melts/water freezes
  - 212° F – water boils
  - 98.6° F – human body temperature

- Anders *Celsius* came up with a new scale in 1742
  - $0^{\circ}\text{C}$  – ice melts/water freezes
  - $100^{\circ}\text{C}$  – water boils
  - $37^{\circ}\text{C}$  – human body temperature
- William Thomson (aka Lord *Kelvin*) devised a new scale in 1848
  - Kelvin scale
  - **Absolute zero** =
    - Lowest possible temperature
    - Equals  $-273^{\circ}\text{C}$



# TEMPERATURE AND DENSITY

When the temperature of most matter  
**INCREASES**

- Volume increases
- Mass stays the same
- Density decreases
- **Expansion** =
  - The increase in the volume of matter with increasing temperature

## When the temperature of most matter **DECREASES**

- Volume decreases
- Mass stays the same
- Density increases
- **Contraction** =
  - The decrease in the volume of matter with decreasing temperature

### Exception: Water

- Water expands and becomes less dense when it approaches freezing
- This is why icebergs float

# CHANGING MATTER

- **Physical changes**

- Changes that do NOT result in the production of a new substance
- Reversible through physical means
- Examples
  - Phase changes
    - Melting, freezing, boiling, evaporating, condensing
  - Breaking, bending, cutting, etc.

- **Chemical changes**

- Changes that DO result in the production of another substance
- Not readily reversible
- AKA: Chemical reactions
- Examples
  - Burning and rusting
  - Digestion and decomposition
  - Photosynthesis and respiration

– **Reactant**

- The starting substance in a chemical reaction

– **Product**

- A substance formed by a chemical reaction

JUST A PHASE



- Remember, phase changes require
  - The gain or loss of heat energy
  - You can't add or take away cold!
- Phase change vocabulary
  - **Melting**=
    - Changing from a solid to a liquid
  - **Freezing** =
    - Changing from a liquid to a solid

– **Boiling** =

- Changing from a liquid to a gas at a specific temperature for that substance

– **Evaporating** =

- Changing from a liquid to a gas at the surface of a liquid
- Can occur at various temperatures

– **Condensing** =

- Changing from a gas to a liquid

SOLID

ICE

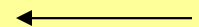
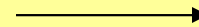
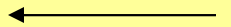
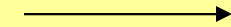
LIQUID

WATER

GAS

WATER

VAPOR



- Melting, freezing, and boiling points

- **Melting point** =

- The temperature at which a solid changes into a liquid
- This is the same temperature as the freezing point!

- **Freezing point** =

- The temperature at which a liquid changes into a solid
- Remember, this is the same temperature as the melting point!

- **Boiling point** =

- The temperature at which a liquid changes into a gas

- Remember **characteristic properties**
  - Attributes that can be used to help identify a substance
    - Unique for each substance
    - Not affected by amount or shape of a substance
  - Examples
    - Melting point, freezing point, boiling point
    - Density
    - How a substance behaves when heated

# Getting Rid of Misconceptions about Phase Changes and Chemical Reactions

TRUE OR FALSE

1. Phase changes are examples of chemical reactions...FALSE

- Phase changes are examples of physical changes
  - NO NEW substance is produced
  - The substance has merely changed state, which can be reversed with the gain or loss of heat energy

2. When a substance changes state (ie-freezes, melts, boils, condenses), its mass changes...FALSE

- In a closed container,
  - There is NO loss of mass!
  - There is NO gain of mass!



3. When a chemical reaction occurs, matter is lost...FALSE

- Matter is conserved in all chemical reactions
  - Matter is NOT destroyed
  - *Reactants* do NOT disappear, but are CHANGED into different *products*

#### 4. Changing the heat input affects the melting and boiling points...FALSE

- Increasing/decreasing the heat input does NOT change the melting or boiling point
  - The temperature at which a substance melts or boils remains the same!
- But the matter could change phases more quickly

5. Substances that boil and melt are always hot...FALSE

– It depends on its melting or boiling point

Phase	Water	Mercury	Methane
Gas			
Liquid			
Solid			